



The Metals Trade in Southwest Asia in the Third Millennium B.C.

Author(s): Tamara Stech and Vincent C. Pigott

Source: *Iraq*, Vol. 48 (1986), pp. 39-64

Published by: British Institute for the Study of Iraq

Stable URL: <http://www.jstor.org/stable/4200250>

Accessed: 17/01/2009 14:29

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=bisi>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit organization founded in 1995 to build trusted digital archives for scholarship. We work with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. For more information about JSTOR, please contact support@jstor.org.



British Institute for the Study of Iraq is collaborating with JSTOR to digitize, preserve and extend access to *Iraq*.

<http://www.jstor.org>

THE METALS TRADE IN SOUTHWEST ASIA IN THE THIRD MILLENNIUM B.C.

By TAMARA STECH *and* VINCENT C. PIGOTT

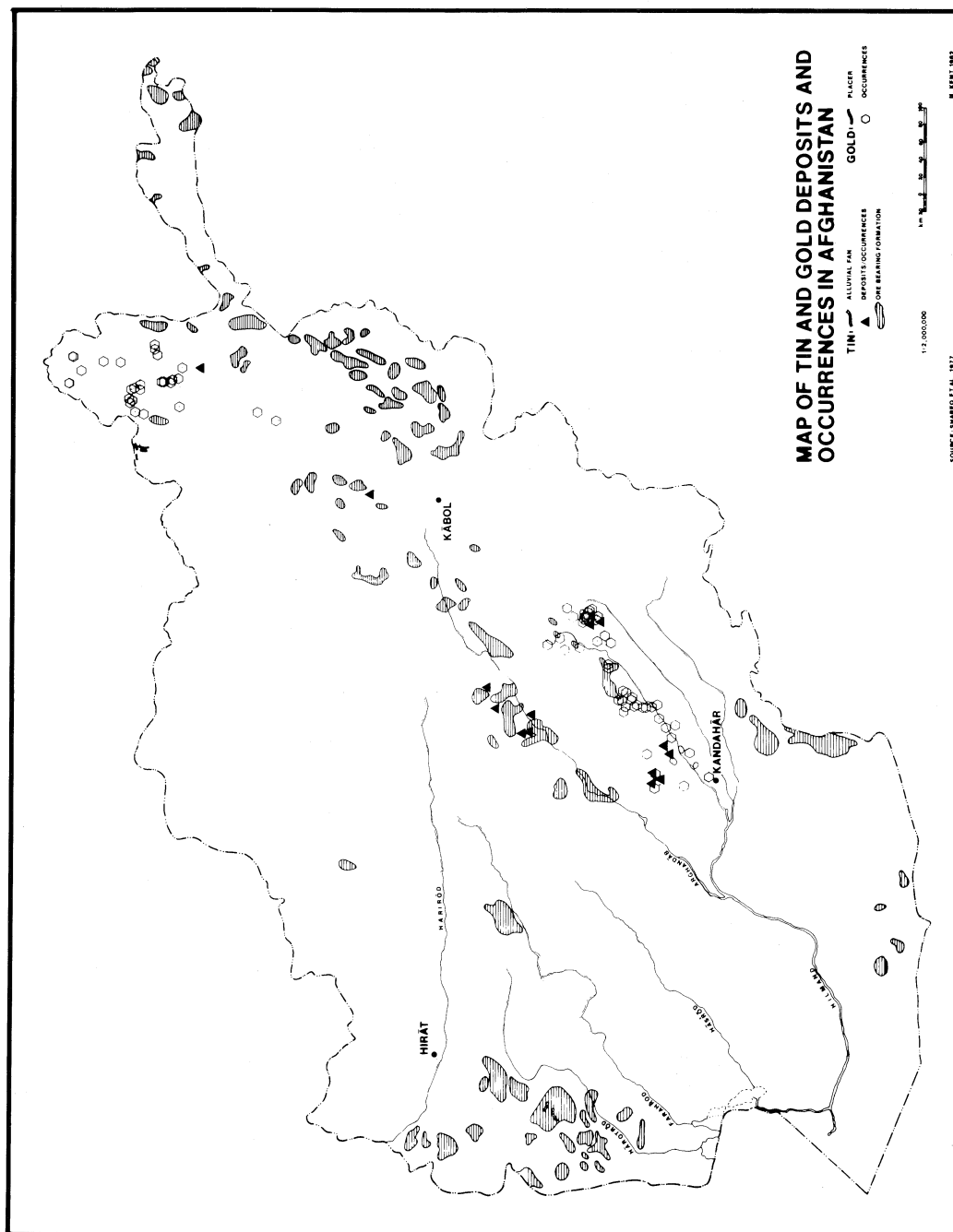
In memory of Theodore A. Wertime

The external manifestations of ancient trading networks have generally been of greater scholarly concern than the internal needs and systems of the societies which created and participated in them. Both aspects of commercial relations are, however, inextricably linked. Preliminary research supports the idea that much of the movement of luxury goods in Southwest Asia during the third millennium B.C. was generated in response to the specific and unique demands of Sumerian society, and that such commercial enterprises continued under the Akkadian rulers. This hypothesis can be used to explain the distribution of certain metals in the third millennium, notably tin and silver. The sources of the tin used in ancient Southwest Asia have, despite considerable research, remained a mystery for years (see most recently Muhly 1985).

Following is a speculative attempt, using archaeological and scientific evidence, to explain the reasons why tin bronze is of limited distribution in Southwest Asia and the eastern Mediterranean during the third millennium. Tin bronze occurs in third millennium contexts in Mesopotamia, the Troad, and central Anatolia, and rarely elsewhere until late in the millennium. Such a pattern of distribution might be explained by the presence of tin deposits in each of these areas, exploited to fill only local needs, but geological research has failed to detect tin ores in any of these places. Since some source of tin was clearly being exploited to supply these areas and because there seems to have been differential access to it, geological presence or absence of tin must not have been a determinative factor. An alternative explanation is here developed by examining the nature of the tin trade and of the entities involved in it.

This article is stimulated by new information on a possible source of tin, and by a number of recent articles on trade between Iran and Mesopotamia. It is hampered by the fact that these articles deal with conclusions based on largely unpublished material, so the interpretations can at present be examined only on theoretical grounds, and by the variation in type and quality of scientific analyses. Because the scope of the problem of differential tin consumption in the third millennium is, in geographical and chronological terms, vast, consideration of its many aspects is sometimes cursory. Another limitation is that only raw materials, and not morphology of finished products, are considered. The problems of dating are also significant, so general chronological schemes are used (see Appendix); a detailed reconciliation of traditional and radiocarbon dates is being made by J. D. Muhly, but it cannot be attempted here. Tentative conclusions are offered in the hope of suggesting that even technological systems may sometimes be controlled by cultural choices and needs, rather than purely practical considerations.

The importance of trade in the economies of Southwest Asia during the third



millennium has been clearly demonstrated (Kohl 1978, 1979). Because the Sumerians were the first group in this area to have established a city-state type of government, and consequently to have a social hierarchy which demanded reinforcement by the activities and commodities which are part of high-level trade, they were unique. Sumer was, in ancient terms, also a resource-poor area, so many of the materials appearing in quantity, particularly in graves (e.g., copper, silver, gold, lapis lazuli and carnelian), had to be acquired from elsewhere. It is therefore likely that some of the long distance exchange networks were generated for, and perhaps by, Sumerian markets and that this situation is largely responsible for distribution patterns of exotic and ornamental goods, materials which were luxuries rather than necessities.

Identification of the participants in long distance trade helps to understand the mechanisms involved. The importance of the Sumerian temple-based economy has been stressed (e.g., Falkenstein 1954; Gelb 1976), although the concept of a temple-state may have been over-emphasized (Foster 1980). While the temple was surely concerned with trade, at least in terms of administration and of centralized storage facilities, some of the actual merchants may not have had a formal relationship with the temple. During the Akkadian period, both the state and individuals participated in trade (Foster 1977). Of special significance are the commodities not mentioned in Akkadian texts: imported luxury materials such as valuable stones and bulk quantities of metal. These commodities must have been obtained through channels outside the sphere of individual merchants, the people who left most of the extant records (Foster 1977: 37–8). The lacunae in the economic documents suggest that at least some aspects of foreign acquisition were controlled by the central authorities, the individuals who were to use the imported exotica. Documentation of Early Dynastic commercial ventures is by no means as clear as the record for the Akkadian period, but it is possible that a dual system of entrepreneurship existed then as well, even given the difference between the city-states of the Sumerians and the nation-state of the Akkadians. The possibility that the most highly valued commodities were traded directly by the interested parties, rather than by middlemen, even in the fourth millennium (Beale 1973: 144–5), suggests that such commercial relationships were in force for a long period of time.

Metals were among the prestige goods. In the Mesopotamian context, metal ornaments appearing in quantity seem to be sensitive indicators of the success of urban nucleation and the fortunes of elite groups. Metal implements are important in understanding the intensification of agricultural production and the development of specialized crafts and industries because modifications and innovations in these spheres of activity are reflected in altered and more diversified tool kits.

Mesopotamia and the East

The desire to obtain exotic commodities led Sumerians to establish networks for their acquisition throughout Southwest Asia, and possibly beyond; in this effort, they may have followed some of the trade routes which had been in force for millennia. But their foreign commercial ventures appear more energetic than those which had preceded them, in that they sought rare materials in bulk which were required on a regular basis. Because the Sumerians were the first people in this area

to have established regional control and to have a developed social hierarchy, they were the first to be able to exploit the resources which had been used earlier in a less systematic and deliberate fashion in the areas where they occurred. The Iranian plateau was one of the areas in which production of some goods developed in response to Mesopotamian demands.

It must be emphasized that peoples in Mesopotamia have always had to look abroad for their mineral (ore) resources. Possible sources include Iran, where major copper deposits ring the central deserts (Bazin and Hübner 1969) around which the vital east-west trade routes travelled. Copper smelting installations such as those at Tepe Ghabristan (Majidzadeh 1979, although the excavator's date may be too early [Mary M. Voigt, personal communication]) and Tepe Hissar (Pigott, Howard and Epstein 1982: 222–4, 230–3) in Iran show that the metal was produced and used as early as the fifth millennium B.C. But, while the material for the production of copper artifacts was probably therefore available to the inhabitants of southern Mesopotamia as early as this date, it was not adopted until much later. In northern Mesopotamia, however, small scale use of metal artifacts, most of which may be classified as ornamental rather than functional, began at least by the fifth millennium at sites such as Tell es-Sawwan (El-Wailly 1964: 2), Samarra (Herzfeld 1930: 2–5), 1932: 11–12), Arpachiyah (Mallowan and Rose 1935: 104), Hassuna (Lloyd and Safar 1945: 262, 284), Yarim Tepe (Merpert, Munchaev and Bader 1977: 72, 82, 95; Bashilov *et al.* 1980: 57, 62), Tell Sotto (Bader 1975; Merpert and Munchaev 1977) and Tepe Gawra (Tobler 1950: 21) (see Moorey 1982a: 17–18). Even in the north it is not until the second half of the fourth millennium, contemporary with the beginnings of metal usage in southern Mesopotamia, that metals were used in increasingly larger quantities for utilitarian purposes (Moorey 1982a: 21–5).

Recent excavations at Tepe Hissar (Tosi and Bulgarelli, in Dyson and Howard, in press), Shahr-i Sokhta (Hauptmann 1980), Tepe Yahya (Heskel and Lamberg-Karlovsky 1980), Tal-i Iblis (Caldwell 1967) and Tal-i Malyan (Nicholas 1980) suggest that copper continued to be produced in Iran at the time when tin bronze was first used in Sumer, shortly after 3000 B.C.

The other metal needed to produce bronze was tin, the sources of which have proved elusive to modern scholars. Surely of significance in understanding the tin trade is the fact that tin bronze is rare in third millennium contexts in Iran, in contrast to Mesopotamia where the alloy is represented abundantly first in ED III contexts (Moorey 1985: 51–68). To date, most elemental analyses obtained of copper-based artifacts of Early Dynastic date from southern Mesopotamia derive from the Royal Cemetery at Ur, simply because of the immense quantity of material found there.¹ Little tin bronze occurs in the south before ED III, although there is evidence for arsenical copper at Jemdet Nasr (3.3% As; Moorey and Schweizer

¹ The Mesopotamian Metals Project, on which many of the metallurgical statements in this article are based, is now in progress at the University Museum, University of Pennsylvania. The collaborative effort of R. H. Dyson, Jr., S. J. Fleming, J. D. Muhly and the authors, it has been funded by the National Endowment for the Humanities. The focus of the research is on third millennium artifacts from Ur, Tell Fara, Nippur, Kha-

fajeh, Tepe Gawra and Tell Billa (University Museum), and Kish (Field Museum, Chicago).

The amounts of major elements other than copper which are used to define an alloy are: 2% tin, so that any problems caused by low levels in tin in the copper ore can be avoided; and 0.9% arsenic, because arsenic usually occurs in very small amounts or in quantities above 0.9%.

1972: 180). The earliest example of tin bronze in Mesopotamia comes from Tepe Gawra in the north—a pin from Level VIII (early third millennium) containing 5.62% tin (Speiser 1934: 102). Unfortunately, Speiser does not publish the inventory number or a photograph of the pin, so the analysis cannot be checked. It is relevant that of thirteen other artifacts from Gawra Level VIII which have been analysed (four by Junghans and Schroder in 1962, unpublished, and nine by the Mesopotamian Metals Project at the University of Pennsylvania), none contains more than traces of tin and only two have more than 1% arsenic. In fact, tin bronze at Gawra is virtually not used before Level VI (Akkadian), when there was a significant increase in the number of copper-based artifacts (from 42 in Level VII to 335; Speiser 1935: 114).

In Iran, tin bronze appears first, albeit in limited quantity, in Susa I(A) (flat axe from the Nécropole [Louvre Sb 11278] 2.3% tin). Continued sporadic usage occurs in Susa B–C–D, but arsenic was the major alloying agent of copper throughout the fourth and third millennia (Berthoud 1979: Table 5). In the highlands of Iran, an arsenical low tin bronze is documented at Tepe Yahya IV C/B (Heskel and Lamberg-Karlovsky 1980: 256–7) and a tin bronze needle at Tepe Sialk III–5 (Ghirshman 1938: 206), and not at any other sites, where arsenical and unalloyed coppers were used, probably because of the nature of international trade rather than technological retardation. This pattern of distributions corresponds to the by-pass phenomenon as described by Beale (1973: 144; see also Moorey 1982b: 88). Similarly, at Hissar, tin does not appear to have been a factor in the metal industry (Pigott, Howard and Epstein 1982: 230) and lapis was not abundant until the late third millennium (Tosi and Bulgarelli, in Dyson and Howard in press). Thus, Susa is the only site in Iran to have consistently used tin bronze; it is noteworthy that the most frequent occurrences of tin bronze are in Susa D (Berthoud, *et al.* 1979: 71; Berthoud 1979: 118–21; Berthoud, *et al.* 1980) when this lowland city was culturally linked with Mesopotamia (Amiet 1979: 197; cf. also Alden 1982: 624–7) and the plateau settlements of Sialk, Malyan and Yahya were abandoned. The relative proportions of tin bronze to arsenical copper represented in the “vase à la cachette” (Amiet, *et al.* 1980) are altered slightly by the consideration of Berthoud’s analyses: four tin bronzes, sixteen arsenical coppers, with three possessing both sufficient tin and arsenic to be classified as alloys. It would seem that the basic metal being used was an arsenic-bearing copper, to which tin was added.

Therefore, the evidence from Iran suggests a link between Mesopotamia and tin, in a pattern of trade which affected (or interested) Iran only slightly. Moorey’s assessment of metallurgical activity on the Iranian plateau during the Bronze Age supports this contention (1982b: 87–8). The major problem in understanding and reconstructing the tin trade lies with the actual sources of the necessary minerals. It is our contention that the tin used in Mesopotamian bronze could have come from the East, as part of the economic interactions which brought other types of foreign goods. It is surely significant that the dramatic increase in tin consumption occurs in ED III in southern Mesopotamia, a time when the basis of political power may have shifted from religious to secular (Charvat 1982).

An Indian source of tin (Chakrabarti 1979) may have supplied the cities in the Indus valley during the third millennium B.C. At Mohenjo-Daro, for example, 6% of

the tools in the lower levels were bronze, while the proportion increases to 23% in the upper levels (see Ratnagar 1981: 81–97 for a survey of the relevant data and literature). Despite the occurrence of tin within India and particularly in Gujarat and Rajasthan (Chakrabarti 1979: 70), and Shaffer's (1982) contention that Harappan trade was primarily internally directed, there might be a connection between the increased use of tin at approximately the same time in both the Indus Valley and in Mesopotamia and the rarity of tin bronze in post-Harappan contexts (Chakrabarti 1979: 65–8). If Harappan tin had come from local sources, we might expect a post-Harappan continuation of tin bronze manufacture. There are two possible explanations for this apparent anomaly: (1) tin used by the Harappans was imported and not local; (2) the changed basis of society meant that tin bronze was no longer necessary for some unknown cultural reason.

Also to be considered in the light of Mesopotamian metallurgy are tin deposits in south central Asia, an area whose potential as a tin producer was long recognized by Wertine (e.g., 1973: 884; 1978: 3–4). One deposit is in Uzbekistan. The presence of tin in exploitable quantities in this area was brought out by Crawford (1974: 243), who noted references by Masson and Sarianidi (1972: 128) and Kuzmina (1966) to tin near the Zeravshan River in the area between Bokhara and Samarkand. A joint expedition of the Uzbekistan and Moscow Institutes of Archaeology investigated several of the tin deposits. Ryzanov (1979) reports that worked tin deposits definitely exist in the area southwest of Samarkand and along the Kok-Su River. Associated artifacts suggest working from the third and fourth centuries A.D., but Ryzanov (1979: 99)² is convinced that exploitation of these sources could have started much earlier. Extensive analytical evidence (Terekhova 1981: 319) indicates, however, that tin bronze was not used in this area before the Namazga V period in the late third millennium (Kohl 1981: xxxi).

In Afghanistan, two other zones of tin mineralization are known (see Fig. 1): the first comprises much of eastern Afghanistan from south of Kandahar to Badakhshan province in the northeastern corner of the country; the second lies some distance to the west and extends from the region of Sistan north to the vicinity of Herat (Shareq, *et al.* 1977). Geological reconnaissance by teams of Soviet geologists during the last decade provided the first indication of the nature of these deposits; some of their reports have recently become available (Chymriov, *et al.* 1973; Shareq, *et al.* 1977). The tin is most commonly found in the form of tin oxide, cassiterite (SnO₂), in polymetallic associations which frequently include copper, lead, gold and occasionally chlorite. Tin contents on the average of 5–6% were noted in several deposits. From all indications the tin deposits in Afghanistan appear to be quite substantial and along with the great variety of other minerals which are found in association with the tin, they could have easily attracted the attention of prehistoric peoples in the areas (Cleuziou and Berthoud 1982; Berthoud, *et al.* 1982).

Shareq and colleagues (1979: 165–90) list the following tin deposits: (a) seven pegmatite districts with tin mineralization in Badakhshan, Maydan, Parwan and Oruzghan provinces; (b) three tin mineral deposits in Herat province (Misgaran),

² This reference and much other helpful information about tin in Afghanistan was given to us by Thelma Lowe.

Farah province (so-called tourmaline deposit) and in Oruzghan province (Taghawlor); (c) forty-four mineral occurrences; (d) eighteen mineral showings, two non-commercial placers and one hundred mechanical mineral haloes distributed across Afghanistan.

All these deposits cannot be described in detail here, but an example of one of the more substantial zones is the mineral deposit at Misgaran, south of Herat. It is 2.5 km long and 50–300 m wide. The western segment (1.5 km long) had copper, magnetite, tin and disseminated pyrite and chalcopyrite. The eastern segment (960 m long \times 46 m thick) had lead-zinc sulphides-cassiterite mineralization in numerous strongly chloritized, silicified veins and nests. One specific type of mineralization present is the limonite-hematite mineralization in nests and gossans. Here cassiterite is found as quartz-cassiterite aggregates cemented by cerussite-hematite-limonite assaying 0.01–6.61% Sn and 0.06–15.00% Pb among others. This deposit shows signs of ancient working (Shareq, *et al.* 1977: 166–7).

The occurrence of tin in the zone southwest of Herat was brought to the attention of archaeologists by the extensive survey of ancient mining sites on the Iranian plateau conducted by Thierry Berthoud and colleagues (Berthoud 1979a: 1979b; Cleuziou and Berthoud 1982). They recovered cassiterite flakes by digging 20 cm down in the alluvial sand of the Sarkar River and then panning this sand in a nearby qanat pool. They also collected several lumps of cassiterite which proved to be very high grade tin ore (Berthoud, personal communication). The geological conformation of the Sarkar Valley consists of granitic hills ringing the alluvial plain of the river; granite (pegmatitic) is the usual host rock for cassiterite, which gradually washes out of the host rock and deposits itself in placers. Therefore, the Sarkar Valley is geologically acceptable as a source of tin.

That tin deposits extend into Badakhshan, the province from which we assume that Sumerian lapis lazuli came (Herrmann 1968: Tosi 1974), is of crucial importance. The possible association between the lapis and tin trades in the third millennium (Muhly 1973: 307; 1985: 281) is supported by the fact that both of these materials find their greatest use in ED III in Mesopotamia (Herrmann 1968: 54; Moorey and Schweizer 1972: 185). As we shall see, gold also may be implicated in the long distance trade.

The deposits discussed thus far are lodes in which cassiterite occurs in association with various other ores. Another type of deposit was, however, probably more important to Bronze Age metalworkers. In stream or river bed placer deposits, granular and nodular concentrations of cassiterite (specific gravity 7), gold in the form of dust and nuggets (specific gravity 19) and traces of platinum group elements (PGE) including platinum, iridium and osmium may aggregate with iron-rich magnetite (specific gravity 5.5) forming “black sands.”

Such placers, which act to concentrate ores (cassiterite, magnetite) and metal (Au, PGE), form where the carrying capacity of a moving body of water can no longer be supported by the water's slackening velocity. The heavier materials being transported such as magnetite, gold and tin are then deposited relatively close together. The black sands serve as a convenient guide to placers potentially suitable for exploitation. Following hand washing of the placer, and during recovery (melting), the tin and PGE present in the placer become incorporated in the gold

regulus, thus providing a clue to the alluvial origins of such gold (Hartmann and Sangmeister 1972: 626). Elemental analysis of 3,300 European Bronze Age gold artifacts indicated that, on the basis of tin and PGE present, virtually all these objects had been made from alluvial gold (Hartmann and Sangmeister 1972: 626–9; Muhly 1977: 76).

Of special relevance, therefore, is the fact that, as Muhly (1977: 76) has indicated:

... tin and gold appear together in the archaeological record. There is very little gold before 3000 B.C., just as there is little or no tin bronze. After 3000 B.C. both gold and tin bronze appear together at a number of sites over a wide geographical area, from the Aegean to southern Mesopotamia.

To date we know very little about the composition of Near Eastern gold artifacts. It has been demonstrated that PGE inclusions are present in several Early Dynastic and later gold artifacts from Ur (Whitmore and Young 1973; Young 1972; Meeks and Tite 1980: 269), suggestive of an alluvial origin for this gold. This should not, however, be taken to imply that all the gold of Sumer came from points as far afield as Afghanistan, for sources are known in Iran and Anatolia (Maxwell-Hyslop 1977: 84–6), as well as in Egypt where large amounts of alluvial gold are to be found (Lucas and Harris 1962: 224–8; Ogden 1976; Meeks and Tite 1980). It is possible, however, that some gold could have accompanied the lapis and tin from Afghanistan (Maxwell-Hyslop 1977: 85–6). But in the absence of extensive analysis of deposits and artifacts, we cannot pinpoint the sources of Sumerian gold, although attempts have been made (Meeks and Tite 1980). The metal consuming proclivities of Sumerians suggest, however, that they would have utilized every known source.

Although gold is not documented in third millennium archaeological contexts in Afghanistan, it is geologically available in substantial vein and placer deposits (Chymriov 1973: 72–7), the latter mode of occurrence being particularly common in western Badakhshan. Concentrated haloes of gold are found in the Helmand-Arghandab uplift and the Hari Rud (river) fault zone. The gold deposits of Afghanistan are described as being of considerable practical interest (*ibid.*: 77). Francfort reports that gold is still taken from the Amu Darya in the Chah-i Ab area near Ai Khanum, and that the method of collection utilizes sheepskins, i.e. fleece. This same method is described by Ibn Khordad, a ninth century Arab geographer (Francfort, personal communication) as well as by Strabo (63 B.C.?–A.D. 24?) who recorded (XI, 2, 19) far earlier a similar extraction process for gold in Pontic Anatolia.

A final piece of evidence on the mineral wealth of Afghanistan comes from the excavations at Shortugai, where in Bronze Age levels Francfort told of finding a fragment of lapis which was a portion of a water worn cobble. The suggestion he made was that, in the absence of any ancient settlements in the lapis mining district of Badakhshan, early sources of lapis may well have been the river stream beds of this region, locales known to yield gold and perhaps even tin.

Egypt has been rejected as a source of tin in the third millennium, despite the geological occurrence of tin in the Eastern Desert, because there is virtually no analytical documentation for the production of tin bronze in the third millennium (Muhly 1978: 45, 48 n. 14; 1985: 283; 97% of 172 Archaic-Old Kingdom artifacts

analysed by Eaton and McKerrell [1976: 171] contained less than 0.5% tin); it is therefore imperative to determine if this alloy was in use in Afghanistan. Unfortunately, Afghanistan is little known archaeologically, and no surveys have been undertaken in the Sarkar area (Berthoud, personal communication). Of questionable significance are the three bronze artifacts found at Ghar-i Mar (Snake Cave) in an assemblage dated by two C14 determinations to the sixth millennium (Shaffer 1978: 89; Shaffer 1978 is used as the basic reference for Afghanistan because he presents the relevant bibliography and an overview of the material in a convenient form). Even if this surprisingly early date for tin bronze production is correct (which it probably is not; see Moorey 1982b: 99 n. 62), there is no indication that this alloy passed into common use after its first appearance. At the most, it might be interpreted as a reflection of early experiments with minerals, an unusual occurrence occasioned by the accessibility of the necessary resources. Of greater significance are the finds at Mundigak where, as indicated by a few published analyses, tin bronze was used throughout the period of habitation, starting shortly after the middle of the fourth millennium and extending through the third (Shaffer 1978: 144). Artifacts with the greatest tin contents are axes and adzes of Period III (*ca.* 3500–2800, although the dates are debated; see Shaffer 1978: 115). No other analyses of Afghan metals are yet available, although those from Shortugai are in progress (preliminary indications are that the metal most used was arsenical copper; H. P. Francfort and Th. Berthoud, personal communications). But even the slim evidence for the use of tin bronze from Mundigak surpasses that from contemporary Egypt, and the persistence of the alloy in the limited sample of artifacts analysed may suggest regular consumption.

Thus, it is now clear that tin is found in regions which could have served as sources for both Mesopotamia and the Indus Valley. Francfort (personal communication) has suggested that Afghanistan had several culture areas with perhaps the tin from the southwest being used at Mundigak and imported to the west, while Shortugai and related Dashly sites were oriented differently. Archaeological and analytical confirmation of Bronze Age exploitation and trade is still lacking but, as our knowledge of where tin is not to be found is becoming increasingly sophisticated, it follows that the Afghan deposits are among the best candidates for the source of Mesopotamian tin. Although there is little more substantive reason to assume that they did supply Mesopotamian markets than there is in the cases of Egypt and Central Asia, we believe that the coincidence of lapis and tin and perhaps gold in relative proximity is significant. Lapis was probably the material originally sought; knowledge of tin bronze would have been gained on expeditions to obtain lapis; and lapis, as well as tin bronze, occurs in Mundigak I (Shaffer 1978: 172). At Shortugai, although tin bronze may not have been part of the metallurgical tradition, lapis working coincides with the period of strongest Harappan influence (Francfort and Pottier 1978: 58–9). If we accept Francfort's hypothesis of two culture areas in Afghanistan, we can postulate an internal trade in lapis with routes from the lapis mines in Badakhshan or from sites with access to alluvial lapis leading both southeast and southwest. Distribution of lapis outside the borders of modern Afghanistan would then have been west from the western province and south from the eastern one.

Since the recently documented tin sources in Afghanistan are unique in Southwest Asia, and since later texts indicate that the tin used in Mesopotamia came from the east (e.g., Muhly 1976: 97–104), it is likely that, in the third millennium at least, Afghanistan was a major supplier of the tin used to its west. The apparent absence of a well developed tradition of tin bronze usage in Iran and the relatively more frequent use of this alloy in ED III Mesopotamia indicate that the tin trade may have been controlled by, or at least concentrated on, Mesopotamia. It is probable that the “invention” of tin bronze took place in the area where the tin occurred; the material imported into Mesopotamia could have been bronze rather than cassiterite or metallic tin, since, as far as we know, there are no published finds of metallic tin from Mesopotamia (new information on this topic is, however, forthcoming from Tell ed-Der; H. Gasche, personal communication), but the identity of the import cannot be stated with certainty. (See *Postscript*.)

Because tin, when added to copper, forms an alloy which is harder, stronger and easier to cast than copper alone, it has generally been assumed that the superior properties of the alloy as well as the ease with which the proportions of the two metals were controllable constituted the major reasons for its adoption. If, however, this had been the case, we might expect to find tin bronze being used in Iran, the area through which tin from Afghanistan would have passed, and Iranian metallurgists would have had easier geographical access than their counterparts in Mesopotamia.

The superior qualities of the alloy tin bronze do not seem great enough to explain the apparent restriction on its availability, especially since arsenical bronze was used throughout Southwest Asia and is an alloy with roughly the same properties (at least those perceptible to the ancient metalworker and consumer) as tin bronze. We suggest the Sumerians wanted to control the tin trade because tin, being of limited occurrence, was a metal which held a special status because of its rarity and the effort necessary to obtain it from far away. Its major use was as an alloying material, but it received its cachet from the difficulty of obtaining it, for the “remoter the source of the specimen, the greater the virtue of the gift” (Harrison 1968: 489) or trade good. Since tin bronze is not greatly different in appearance from arsenical copper (the latter may have a more satiny luster and a slightly duller colour), the advantages of using tin bronze would not have been visible or functional ones, and therefore must have been ones of status which were conveyed verbally. To conceive of a material which is not yet readily identifiable as special or unusual but which bore status is difficult, yet the indications are that it did. It is possible to speculate that control of the tin trade was assumed in part to obtain another specific material, also of limited occurrence. We submit that this material must itself have been rare and desirable. Two obvious candidates among the exotic materials used in Mesopotamia in the third millennium are gold and silver. Although by no means common, gold, as we have noted above, was available, at least geologically, in Iran, Anatolia and Egypt, as well as in Afghanistan.

Silver is, however, a more elusive commodity than gold. Textual (Maxwell-Hyslop 1971: 1) and artifactual evidence do indicate the use of silver in Mesopotamia before 2500 B.C., while the finds from the Royal Cemetery at Ur clearly establish silver as a desired import. Pre-ED III silver artifacts occur at: Khafajeh (a loop on a cylinder seal, Sin Temple II; Delougaz and Lloyd 1942: 16,

fig. 11a), Uruk (in the *Sammelfund* and the Anu precinct; Heinrich 1936: 14, 40, 47; Le Breton 1957: 93), Ur (in two "Jemdet Nasr" graves; Woolley 1955: 116, 118) and Agrab (Delougaz and Lloyd 1942: 266–83, Pl. 1n). Iran has substantial deposits of argentiferous lead (Taghizadeh and Mallakpour 1976) and silver artifacts occur at several sites. At Tepe Hissar there are seven silver artifacts in graves of Schmidt's period II (E. Schmidt 1937: 121), twelve in Level IIIB and twelve from the remainder of III (1937: 208–12). Virtually all are ornaments—pendants, earrings, rings, beads, bracelets and diadems—with a few vessels late in the series.

Analytical data resulting from the restudy project at Hissar (Dyson and Howard in press) indicate that lead was being smelted in the Craftsmen's Quarter on South Hill (Pigott, Howard and Epstein 1982: 227; Andreas Hauptmann, personal communication). Thus, the silver in the graves of period II and III could have been locally produced, cupelled from the lead being smelted at the site. Among the slags and other metallurgical by-products covering the site of Hissar are pieces which appear to be litharge, but this identification has not yet been confirmed in the laboratory. Other silver artifacts from Iran before 2000 B.C. are from: (1) Susa—pendant from a tomb, Cb or Ca (Amiet 1966: 87, fig. 46; Le Breton 1957: 109, fig. 27: 6), and late in the third millennium, an elaborate silver axe and earrings from a tomb (Amiet 1966: 242, fig. 175); (2) Sialk—two silver sheet buttons in a tomb of Level III (Ghirshman 1938: 54); (3) Giyan—three tombs of Level IV yielded silver spiral earrings (Contenau and Ghirshman 1935: 36–7; for their identification as ear-rather than hair-rings, see Bordaz 1973: 34–52); (4) Shahdad—an engraved plaque, a pin head on a copper shaft (Hakemi 1972: nos. 269, 250) and some beads (Hakemi 1970: 188); (5) Shah Tepe—two spiral earrings in a grave of Level III (Arne 1945: 297, fig. 636); (6) Bani Surmah—silver rings in tombs of ED IIIa date (Van den Berghe 1968: 57–8); (7) Shahr-i Sokhta—a silver plaque with a scene engraved on it (Piperno n.d.: 145, Pl. 31) and a silver stamp seal with stepped edges (Piperno n.d.: 257, no. 7, p. 32), both of third millennium date; (8) Tepe Farukhabad—a twisted piece of silver wire from a Jemdet Nasr context (H. T. Wright 1981: 152). It is thus clear that silver was available in third millennium Iran, although its use was not extensive except at Hissar, where local sources of silver were probably exploited. But the enormous increase in silver artifacts seen in ED III Mesopotamia is not paralleled in a potential source area—Iran—probably because of differences in social structure.

Silver is said to occur in Bactria, and silver artifacts which may come from Dashly sites have appeared in the Kabul bazaar (Pottier 1980; H.-P. Francfort, personal communication, based on research by M.-H. Pottier). As with gold, there is no silver from third millennium archaeological contexts in Afghanistan. The Fullol hoard from northern Afghanistan, a group of gold and silver vessels of apparently diverse provenance and chronology, constitutes the only known example of precious metals (Maxwell-Hyslop 1982; Tosi and Wardak 1972). The geological survey reports virtually no silver in the country (Shareq, *et al.* 1977: 253–4); of the numerous lead deposits, none contains more than 0.001% of silver.

It is therefore especially noteworthy that Marco Polo says of Badakhshan, "There are mountains likewise in which are found veins of lapis lazuli . . . The mines of silver, copper and lead, all likewise very productive." Sources of silver in Iran or

Afghanistan would fit with the textual references to Sumerian silver coming from the East (Potts 1982: entries on pp. 46–9). Because silver is virtually unknown in pre- or post-Harappan contexts in the Indus Valley, Ratnagar has postulated that Harappan silver came from Mesopotamia, perhaps in exchange for goods (Ratnagar 1981: 144–6). If in fact silver functioned as a sort of currency to be used in exchanges, it is particularly important to understand its sources and distribution. In terms of bulk production of silver, there is another area which should be considered as a supplier during the third millennium—Anatolia, which has the greatest quantity of geologically verified silver-bearing ores of any part of Southwest Asia (de Jesus 1980: 64–9) and also some of the earliest tin bronze.

Mesopotamia and the West

There are textual indications of Mesopotamian interest in silver (or at least some precious metal) from the mountainous area to its northwest. Documentation is provided by an Old Babylonian transcription of the text on a statue of Sargon, in which the phrase “Ebla to the Cedar Forest and the mountains with precious metal” appears (Hirsch 1963: 38, Sargon 62; Hirsch declines to name the “precious metal,” which is usually translated as silver; see Pritchard 1955: 268). The Akkadian epic “The King of Battle” (e.g., Güterbock 1969) is a quasi-historical indication of the commercial importance of what is presumably the Taurus (the “Silver Mountain”). These textual references, combined with the geological potential of Anatolia to have been a major producer of silver, suggest that the desire to obtain silver may have encouraged Mesopotamian commercial expansion to the northwest (Yener 1983).

The distribution pattern of silver in the Levant and in the fourth and third millennia (Prag 1978) may provide indirect support for the suggestion that a special commercial relationship could have existed between Anatolia and Mesopotamia for most of the third millennium. The most lavish use of silver in the fourth millennium was at Byblos, where silver objects appeared in many eneolithic tombs (the exact number is not known because not all the tombs are published), almost to the exclusion of copper and gold. Prag (1978: 36) accepts a fourth millennium date for the eneolithic cemetery at Byblos, and thinks that the silver artifacts predominate in the later tombs in the series. Egyptian artifacts found at Byblos suggest that the Syrian port “may have played a central role in the silver trade in the fourth millennium” and may have had direct commercial links with Egypt (Prag 1978: 41). The apparent cessation of the Levantine silver trade in the late fourth-early third millennium, concluded from the facts that few silver artifacts of third millennium date occur in the Levant and that local sources of auriferous silver appear to have been exploited more heavily in Egypt (Gale and Stos-Gale 1981a: 108–9, 111, 114), is paralleled by the interruption in the lapis trade (Herrmann 1968: 53–4; Crowfoot Payne 1968: 59). Prag suggests that the working out of a Syrian silver source created this situation (1978: 41). No silver sources are geologically verified in Syria, but the abundance of this material in eneolithic Byblos points to steady access to a fairly rich source, which could have been Anatolia.

Non-metallurgical evidence indicates a link between eneolithic Byblos and Anatolia. The practice of multiple successive burials in large pithoi at Byblos is most

closely paralleled in the EB II cemeteries of western Anatolia, and is not typical of Syria or Palestine where cave burials and inhumations in earth were common from the Neolithic period onwards (for the evidence and a fuller discussion, see Stech Wheeler 1974: 421–3; and Dunand 1973). The similarities between burial modes in these two areas are too strong to be fortuitous; the conclusion may be that they represent two parts of a loosely connected culture, based on maritime communication and with a geographically intermediate representative in the Chalcolithic children's cemetery at Tarsus (Goldman 1956: 6–7). The major difficulty in making the linkage is that, according to traditional dates, the Byblos cemetery ends before the western Anatolian series begins, although several scholars have advocated lowering the Byblos dates (cf. Amiran 1960: 221, 223 and Oren 1973: 33–4, although their dates are probably too low; see Richard 1980: 23). The Byblos cemetery is incompletely published at present so it is not possible to assess in detail the type of material culture represented. Nevertheless, even if one uses the excavators' dates for the Byblos cemetery (3900/3800–3200 B.C.: Dunand 1973: 16), there may not be a great gap from the cemeteries of western Anatolia, which, on the basis of the calibrated Karataş C14 dates (see Appendix), might be pushed back to about 3000 B.C. Perhaps of significance in this context are the facts that the richest metal finds occur in the earliest tombs in the Karataş cemetery and silver artifacts are more numerous than gold (Stech, forthcoming); parallels exist in the grave goods of Ahlatlı Tepecik (Mitten and Yügrüm 1971: 193–4, figs. 4, 6, 7a–b; 1974: 26). The Byblos-silver-western Anatolian connection cannot be explained at present, but its existence in terms of natural resources and at least some aspects of material culture is reasonable. Silver occurs in several parts of western Anatolia; the major deposits are at Balya Maden in the Troad and Gümüş on the southern Aegean coast (de Jesus 1980: 65, 68–9, 76; Yener 1983).

One of the difficulties in bringing western Anatolian silver to fourth millennium Byblos is that there is no evidence for silver usage in Anatolia before the end of the millennium or the beginning of the next. The silver ring from Beycesultan XXXIV (D. Stronach in Lloyd and Mellaart 1962: 180–3) is probably, despite the excavators' earlier dating, more or less contemporary with the silver objects from two late Chalcolithic graves at Korucutepe (Brandt 1978: 61–2) and with two earrings from Alişar 14M (von der Osten 1937: 31–3). A date around 3000 B.C. is reasonable for these artifacts. Silver artifacts occur at Troy from the time of its foundation (Schliemann 1880: 249–52, no. 112 on 249, 121 on 250) and silver ingots appeared in Treasure A of Troy II (Schmidt 1902: 236–7). In other parts of Anatolia silver items increase in number and variety throughout the third millennium, a pattern paralleled in Mesopotamia, with spectacular concentrations coming in the "royal" tombs of each area: Ur, and Alaca Hüyük and Horoztepe. In contrast, there are virtually no silver artifacts of third millennium date from the Levant. One reason for such a distribution of silver might be that the bulk of Anatolian silver was traded to Mesopotamia in the third millennium, in a commercial relationship that was initiated by Mesopotamians who wanted silver so they introduced a new metal and its technology in trade. The contention that this metal was tin is supported by an examination of the distribution of tin bronze in the third millennium.

Sorting out the evidence on tin bronze is, however, difficult. A number of analyses

have been performed by a number of techniques; some researchers have not looked for arsenic in copper alloys, so the relative proportions of tin bronze and arsenical copper cannot be accurately determined; the chronological assignments of the artifacts tested are often unclear, and occasionally imprecise. The analytical program of Eaton and McKerrell (1976) has several advantages in the arguments presented here: the large number of artifacts studied (around 2000); the broad geographical and chronological range covered (Iran through Etruria, *ca.* 3000 to Roman); the use of a single analytical technique so the results are comparable among themselves. Eaton and McKerrell have, however, published only the summary and interpretation of their results, so we do not know which individual artifacts were tested, and therefore cannot make critical judgments about their dates and types. The general statements and cautionary remarks advanced by Moorey in 1972 (p. 185) still, however, appear to be valid, and basically conform with the work of Eaton and McKerrell: Tin bronze was in use in Mesopotamia by ED IIIA (see also Muhly 1980: 151), and seems to have limited distribution in wealthier graves. The production of arsenical copper objects declines after the introduction of tin bronze (Moorey and Schweizer 1972: 194).

The situation in Syria is not so easy to characterize because fewer analyses are available, but the area does not seem to have a developed tin bronze metallurgy until the Middle Bronze Age (Muhly 1973: 332–3). The cache of figurines from Tell Judeideh (Amuq late G or early H: Braidwood, *et al.* 1951: 91, 94–6), unique tin bronzes of the earlier part of the third millennium, may simply show the direction of the tin trade to the west rather than being representatives of metallurgical change (see also Stronach : 1957 113–17). Their somewhat anomalous stylistic position and the apparently isolated phenomenon which they represent makes explanation of their significance difficult (Muhly 1980: 153); and the archaeological context to which they are assigned has been questioned (Seeden 1980: 8, n. 28). The earliest archaeological evidence for tin bronze in Syria which seems reliable comes from Tell Sweihat of the late third millennium (Hedges 1976), and mentions of tin and the making of bronze in texts found at Ebla in what apparently is an ED III context are surely relevant and are consistent with the importance of the site (Pettinato 1981: 178). None of the metal artifacts found at Ebla has yet been analysed. Palestine (Moorey and Schweizer 1972: 192; Gerstenblith 1980: 66, 75) and Cyprus (Muhly 1973: 334; Swiny 1982: 76–7) do not become regular consumers of tin bronze until around 2000 B.C., although a few examples of EB IV bronze are now known from Palestine (Maddin, *et al.* in press).

Anatolia remains the only area in Southwest Asia west of Mesopotamia in which tin bronze occurs regularly, at least during the second half of the third millennium, along with arsenical copper and unalloyed copper. The published analyses are many, with concentration on the Troad and central Anatolia. For the Troad, we have analyses by wet chemistry by Desch (see Tylecote and Tylecote 1966: 20–7 for a compilation), by optical emission spectroscopy (Esin 1969: 142–4; Bittel 1959: 34) and by X-ray fluorescence (Eaton and McKerrell 1976: 171–2). A number of analyses performed at the behest of the early excavators was collected by Przeworski (1939: 94–9). By our count, analyses of 139 different artifacts exist. Twenty-two are of a group of artifacts without excavational context although convincingly

attributed to the Troy II period by Bittel (1959: 323); Esin presents analyses of ten unpublished artifacts from Troy which are in the Istanbul Archaeological Museum (although the level of Troy from which they come is not specified in the text, she assigns them an EB date); Eaton and McKerrell do not identify the artifacts which they tested, and have grouped Troy I–II separately from Troy III–VI when it would have been more useful to have separated II–V from VI, at least for the purposes of this study. Therefore, 93 of 139 analyses are of artifacts which can be dated only to the third millennium. Of the remainder, only those by Desch (21) include the determination of arsenic (as far as we can tell).

The analyses are presented here in tabular form. One per cent was chosen as the amount above which a deliberate alloy may be said to exist; in the case of tin bronzes, those with tin contents in excess of 5% are also given to indicate indisputable alloys. Question marks reflect uncertainty about the reporting of the data. (The use of 1% as the minimum amount of tin needed to establish the presence of an alloy is necessary in this section because that is the figure given by Eaton and McKerrell. Since they have not published individual analyses, we do not know which artifacts contain more than 2% of tin or arsenic.)

<i>Sn 1–5%</i>	<i>Sn > 5%</i>	<i>As > 1%</i>	<i>Unalloyed Cu</i>
17	56	52?	15+?

The analyses which correspond to individual levels of Troy are:

	<i>Sn 1–5%</i>	<i>Sn > 5%</i>	<i>As > 1%</i>	<i>Unalloyed Cu</i>
Troy I	0	1	3	3
Troy II	7	10	4	1
Troy III	1	1	2	0
Troy IV	0	0	2	0
Troy V	0	2	?	?
Troy II–V	1	1	0	5

The re-analysis of the samples published by Esin indicates that tin, as detected in the Stuttgart study, should in general be corrected to a higher level (Stos-Gale, *et al.* 1984: 39). Only one artifact—a flat axe from Troy II, Esin no. 11808—seems to have less tin than was detected in Stuttgart. The new data clearly demonstrate the difficulties inherent in comparing analyses done by different means in different laboratories at different times. The data do seem to indicate that tin bronze metallurgy was available at Troy sometime during the third millennium (early) and that it existed simultaneously with arsenical copper and to a lesser extent unalloyed copper. Alloyed copper thus seems to have been the preferred metal. The data may also suggest that tin bronze metallurgy became an important factor during the time of Troy II, but the analyses of Troy I artifacts are too few to permit any conclusions, even negative ones (on the probable lack of bronze in Troy I, see Muhly 1985: 283–4).

The samples processed in Stuttgart have also been republished by Pernicka and colleagues (1984: 578–96), who in addition analysed eight artifacts from the Early

Bronze Age "Yortan" cemeteries of western Anatolia. Seven of the last are arsenical coppers, while only one has a tin content in excess of 1%; the comparable figures for Troy in this study are 6 and 16; for the Troad group published by Bittel (1959), 5 and 13. These findings are consistent with our thesis that the exchange of tin was not a widespread phenomenon, not even within the general cultural sphere of Troy, but directed toward that site alone (and perhaps others very close by, like Beşiktepe). Another piece of supporting evidence is the demonstration that arsenical copper was the dominant metal used at İkiztepe on the Black Sea coast directly north of Alaca Hüyük (Özbal 1981).

For central Anatolia EB II–IIIa, Eaton and McKerrell analysed 112 artifacts from Polatlı, Alaca Hüyük, Alishar, Ahlatlıbel and Kültepe. Among Esin's analyses these sites are also represented: Polatlı (6), Alaca (36), Alishar (22), Ahlatlıbel (22) and Kültepe (3), for a total of 89. As with Troy there are a number of other analyses, usually a few for each site which were commissioned by the excavators. Because of the number of sites and artifacts involved, tabulations will be confined to the results of these two analytical programs, and the sites included by Eaton and McKerrell.

<i>Sn 1–5%</i>	<i>Sn > 5%</i>	<i>As > 1%</i>	<i>Unalloyed Cu</i>
14	47	73	24+?

The following breakdown by sites is based on Esin's data:

	<i>Sn 1–5%</i>	<i>Sn > 5%</i>	<i>As > 1%</i>	<i>Unalloyed Cu</i>
EB I—				
Alishar	0	0	2	1
EB II—				
Polatlı	3	0	3	0
Alaca	1	12	13	10
Alishar	3	0	12	6
Ahlatlıbel	0	8	8	6
Kültepe	0	0	2	1

The breakdown suggests several reconstructions of central Anatolian metallurgy. Tin bronze is certainly present, but it is not as proportionately well represented as it is in the Troad, achieving this status only at Alaca and Ahlatlıbel. The indications that arsenical copper was more popular than tin bronze might result from the nature of local resources. Of particular importance could be reports of enargite (a copper arsenic mineral) near Gümüşane (de Jesus 1980: 91), a rich silver-bearing area. Arsenic-bearing ores do, however, appear to be more common in western Anatolia (de Jesus 1980: 91 and map 11), so the greater tin bronze consumption of the Trojans might represent a choice made for reasons other than technological. A second possibility is that the tin which reached central Anatolia came there by way of Troy and that there was no regular, more or less direct exchange between central Anatolians and Mesopotamians before the late part of the third millennium. This alternative appears reasonable in light of the documented commercial relationships between the Troad and central Anatolia (Bittel 1959: 31–3; Mellink 1956: 47–54,

57–8). If it can be accepted that the use of tin in the third millennium was as much a cultural matter as a technological one, then the proportion of tin bronzes in the Alaca tombs may support the indirect acquisition of tin by central Anatolians, at least in EB II. The Alaca tombs contain material which should be viewed as the expression of status and wealth; might not the richest among the central Anatolians (as far as we know) have been the ones to acquire and use more of a metal from far away?

The Horoztepe analyses may be interpreted to support the contention that tin bronze was a metal used by the elite. Over half of the 56 artifacts tested were made of tin bronze (de Jesus 1980: 130), while about a quarter were of arsenical copper. The possibility that the Horoztepe cemetery is slightly later than the Alaca tombs (EB III in Anatolian terms, see Özgüç 1958: 53–8) could also indicate that supplies of tin or bronze had become more regular, perhaps because a direct connection between central Anatolia and Mesopotamia had been established (cf. Yener 1982: 52). Recent salvage excavations in southeastern Turkey along the Euphrates have revealed a fairly intensive pattern of settlement in EB III, which may be stronger than in EB II (Mellink 1981: 468–9). These sites may have grown up or become more populous as a result of the establishment of overland trade routes which bypassed Troy. The third city of Troy, although by no means an insignificant settlement, does not appear to have been as wealthy and stable as Troy II (Blegen, *et al.* 1951: 5–6, 8–10). Also to be considered are the sites of Tarsus and Mersin, where unalloyed copper was the metal most commonly used throughout the Early Bronze Age (de Jesus 1980: 132–4). The apparently small scale of tin bronze metallurgy in Cilicia may be another indication of the maritime linkage between Anatolian silver and Afghan tin from Mesopotamia (despite the silver deposits in Cilicia; see de Jesus 1980: 64) and Troy II as the point where the two metals were exchanged, at least during the EB II period. The connections between Syria and Cilicia were stronger in EB III than EB II (Mellink 1962: 225–6) but tin bronze metallurgy does not appear to have been a concomitant of increased exchange. Central Anatolia was the focus of the tin trade, perhaps because a well established market existed there. This area maintained close connections with Syria and Cilicia as well (Özgüç 1964: 11), so the lack of tin bronze may be another indication of a trade specifically directed toward a single area and a single commodity. In the absence of analyses of artifacts found in the upper Euphrates area, a focused trade in tin seems the most reasonable possibility (on trade in this area, see Yener 1983).

The idea that Troy was an emporium enjoying widespread commercial relations during the third millennium is certainly not new (Mellink 1956; Canby 1965: 52–4; Wright 1974: 35–6), but it has received further confirmation from geological studies of the Troad. Third millennium Troy was on a promontory surrounded by water on three sides (Kraft, Kayan and Erol 1982: esp. 32–5). The site itself is a citadel, rather than a city; its size and the number of buildings (Bittel 1959: fig. 32 on 17) have always seemed small in relation to its wealth and assumed status. It is likely Troy was founded to take advantage of several different trading networks, and that control of goods could have been exercised by a small number of people because of the strategic location and the local availability of several desirable products, such as silver and arsenical copper, which would have provided the basis for commercial

exchanges. Of potential importance in understanding trading patterns in Early Bronze Age western Anatolia are the new Turkish excavations at Klazomenai-Liman Tepe, where a monumental building and fortification wall of the Troy I period are being uncovered. No strata contemporary with Troy II have yet been found; private houses of Troy VI date occurred in the upper level (Mellink 1981: 467). Also significant will be the German excavations at Beşiktepe (Mellink 1984: 446).

Conclusions

The traditional view of bronze metallurgy in the third millennium has been that arsenical copper, used virtually everywhere in Southwest Asia, including Mesopotamia, the entire Mediterranean area and Europe, was abandoned late in the period in favour of tin bronze, because the properties of arsenic were inferior to those conferred on copper by tin or because the toxicity of the fumes given off during the processing of arsenical ores was recognized (Charles 1967: 26). Current information indicates that the properties of the two alloys are about the same (Charles 1967: 21–4; Bohne 1965: 128–30; Lechtman 1980: 315 and 334 n. 137) and that the evolution of the toxic gases can be controlled by smelting in a closed reducing atmosphere (McKerrell and Tylecote 1974). The lack of knowledge about the locations of tin sources gave rise to speculation (based on numerous unconfirmed geological reports, ancient textual references and the distribution of tin bronze artifacts) that they were to be found in the Troad, Syria and Iran, among other places. Cassiterite was finally found in Egypt, but this only proved perplexing because tin bronze was not a part of Egyptian metallurgy until the second millennium (Muhly 1977: 45 and 48 n. 14).

The geological verification of tin and the evidence for tin bronze usage in Afghanistan and the already known trade routes bringing lapis and other exotic goods to Mesopotamia from that part of the world have considerably clarified the “tin problem.” The sporadic appearances of tin bronze in Iran and its more regular use in Mesopotamia suggest that the Sumerian-Akkadian market demanded this metal. Because tin is rare and its source distant, and because it was obtained with a number of other luxury materials, probably lapis lazuli and gold, we believe that it too was regarded as exotic, and that it and its attendant technology may have been part of a material complex which expressed the unique position of the Sumerian and Akkadian upper classes (see, for example, Moorey and Schweizer 1972: 185). Tin was unusual in this complex because its value was secondary—as an alloying material—rather than primary, a role which indicates awareness of the properties of tin bronze. Although arsenical copper was a similar product, it was not as rare, with known occurrences in Anatolia (de Jesus 1980: 91), Cyprus (Zwicker 1982: 64–7) and Iran (Heskel and Lamberg-Karlovsky 1980: 233, 259). Therefore, it may have been culturally less desirable. The model which seems most applicable to the pattern of exchange between Sumer and Afghanistan is that of a “directional trade,” (perhaps more accurately a pattern of acquisition) in which commodities are exchanged directly between distant areas without middlemen (Clarke 1978: 431). Trade in the early third millennium probably involved both these elements. Cultural and technological factors may therefore be responsible for the use of tin bronze in

Anatolia, and apparently nowhere else in Southwest Asia west of Mesopotamia before the late third millennium. Both of these factors must have been equally desirable to the Anatolian recipients of the tin; their concern with the demonstration of wealth and status is apparent in the “treasures” of Troy and the contents of the Pontic tombs. Trade between Anatolia and Mesopotamia would therefore have been of the “prestige chain” type, in which a limited number of prestige goods were exchanged between people of high social rank (Clarke 1978: 429–31).

The suggestion that Afghanistan was the source of at least some of the tin used to its west in the third millennium raises several problems. First, if we assume that in southern Mesopotamia in ED III about $\frac{1}{3}$ of all copper/bronze artifacts are in fact tin bronze, $\frac{1}{3}$ in the Troad, and perhaps $\frac{1}{5}$ – $\frac{1}{4}$ in central Anatolia, we must reconstruct a trade in large quantities of material. Second, why would the Sumerians have selected tin from among the exotic commodities coming to them as appropriate for the Anatolian market? Or did the Anatolians make the choice? The former possibility seems more likely because Anatolians would not have known about tin until it was introduced from another source. Significant in understanding the nature of the commercial relationship must be the virtual lack of lapis lazuli in third millennium Anatolian contexts. Identified as lapis are only two hammer-axes, one from Troy II–V (Dörpfeld 1902: 375, fig. 326) and the other from Dorak (Mellaart 1959: colour p. 11, fig. 11) and a sword with lapis pommel and lapis dolphins set into the hilt from Dorak (Mellaart 1959: colour p. 111, fig. 18E). There is now no way of verifying the material of which the Trojan axe was made and the Dorak finds are of dubious archaeological value. Therefore, the trade between Anatolia and Mesopotamia—at least the aspects of it now visible—appears to have been in metals alone. This fact indicates that the trade was not of random nature, conducted by individual entrepreneurs who would have been desirous of selling everything available to them. Bulk and exclusivity point to the strong control which could only have been exercised by Mesopotamian political leaders.

Even people in areas remote from Mesopotamia must have been aware of lifestyles in the southern river valleys, and their leaders may have wished to acquire the power and wealth which appeared to be associated with urban living. The disruptions and changes in Anatolia during the late third millennium culminated in the rise of urban centres which became international emporia. The sixth city of Troy does not, however, appear to have been the economic successor of earlier settlements on the site, an indication that something must have shifted the balance of trade, since the natural resources which had been the basis of Early Bronze Age trade were of course still present.

When the more or less unified culture of Mesopotamia, represented by the Sumerians and the successor-state of the Akkadians, broke down in the late third millennium, the control, and perhaps even the existence, of the extensive eastern trading network ended for perhaps a hundred years. By the time political reorganization had been achieved in Mesopotamia, the map of Southwest Asia had changed. During what appear to have been considerable ethnic movements in the late third millennium, different political and social entities had developed; tin bronze had become a necessity of life for social *and* practical reasons; new sources of tin were sought. It is likely that European sources were first systematically exploited at this

time and may have become partial suppliers of tin to the eastern Mediterranean (see Taylor 1983 on tin in the Erzgebirge; and contra Muhly 1985: 288–90). Since other areas were achieving the kind of social and political organization which before had been peculiar to Sumer, a centralized control over tin acquisition and distribution could not be maintained. Tin bronze usage became widespread in Europe and Southwest Asia. Mesopotamians of the later third and second millennium B.C. again became involved in the tin trade, for economic rather than social reasons, and their ventures in this sphere are well documented.

Tin was originally a status metal, prized because of its rarity and the great distance which it had to be brought; eventually it became used for the practical improvements it wrought in copper. Tin was traded for other materials, probably precious metals, which were needed to reinforce the special status of the Sumerians and the Akkadians; the spectacular finds from the Royal Cemetery at Ur clearly illustrate the importance of metals and other imported luxury goods like lapis lazuli in the economy of the Sumerian upper classes. Therefore, tin bronze for most of the third millennium appears only in those areas of Southwest Asia, specifically several parts of Anatolia, which had contributions to make to Sumerian and Akkadian society.

Postscript

Since this article went to press, a report on metals found at Tell ed-Der has been published: K. Van Lerberghe and L. Maes, "Contribution à l'étude des métaux de Tell ed-Dēr," in L. Meyer (ed.), *Tell ed-Dēr IV* (Leuven 1984), 97–143. There, seven objects of tin were found in three tombs of the early second millennium. The authors discuss the problem of tin in general and of its preservation in Mesopotamian sites.

Appendix

The general chronological scheme used here is that of Mellink (1965: 126): Mesopotamian ED I–II = Tarsus EB II = Troy I; Akkadian Period = Tarsus EB IIIa = Troy II = Kültepe EB IIIc–b.

In absolute dates (calibrated C14), the first group would fall into the period roughly 3200–2500 B.C. (For the first figure the Karataş dates are used, for the second those from Emporio—marking the end of the "Troy I" level—and Korucutepe—end of the EB II, which can be correlated with the end of Tarsus EB II; see Easton 1976: 150, 152–3, 170–1). The transition from ED I to ED II in Mesopotamia comes *ca.* 2900 using the Suess calibration or in the mid-27th century on the MASCA curve (Adams 1981: 82).

Easton's chronological conclusions are rendered inaccurate by Yakar's (1979) study of the position of Troy in the temporal world of the Early Bronze Age and by a recent study of Karataş, the site which he deems crucial (Stech forthcoming). The tombs in the main cemetery at Karataş are not contemporary with the megara and Troy II-style pottery (as Easton 1976: 152); they are contemporary with Mound phases II–V and Troy I. The tombs are almost entirely EB II in the Karataş scheme. The suggested sequence for Karataş is: EB I = Mound I–II = a few tombs very late in the period (including 367, the built tomb) = Troy I; EB II = Mound

III–V = most of the tombs = Troy I; EB III = megara and Troy II-type pottery = possibly two tombs.

The six calibrated C14 dates for the end of Karataş, mound II, are remarkably consistent in clustering round 2950–2930 B.C. This date falls somewhere within Troy I and marks the beginning of EB II; the important point is that most of the tombs do not contain elements paralleled in the Troy II repertoire. Their estimated number (386 excavated of a conservative estimate of 2000), and apparent village size (probably not more than fifteen houses during the time the cemetery was used), suggests that the period which they cover was of considerable duration.

Acknowledgements

A great debt must be recorded to Judith Kingston Bjorkman, whose master's thesis in the Department of Oriental Studies at the University of Pennsylvania, "A Sketch of Metals and Metalworkers in the Ancient Near East" (1968), has been an invaluable source of information. Because it is a master's thesis and is therefore not available in microfilmed edition, we have not cited it here, although we have consulted it extensively.

We are grateful to our colleagues—Th. Berthoud, B. Bronson, H.-P. Francfort, R. Maddin, M. J. Mellink, J. D. Muhly, G. Possehl, T. Lowe and I. Winter—for their thoughtful advice on this manuscript. We owe a particularly great debt to P. R. S. Moorey for his comments, criticisms and bibliographical assistance. S. J. Fleming and C. Swann have generously provided the elemental analyses which form the basis of some of the discussion. We also wish to thank Drs. Stos-Gale and Gale for generously making their manuscripts (1981 a and b) available prior to publication. E. Dizon rendered considerable technical assistance, for which we are grateful.

Bibliography

- Adam, R. McC., 1981. *Heartland of cities*. University of Chicago Press.
- Alden, J. R., 1982. Trade and politics in proto-Elamite Iran. *Comments. Current Anthropology* 23: 613–40.
- Amiet, P., 1966. *Elam*. Auvers-sur-Oise, Archée.
- Amiet, P., 1979. Archaeological discontinuity and ethnic duality in Elam. *Antiquity* 53: 195–204.
- Amiet, P., Berthoud, T. and Lissak-Hours, J., 1980. La spectrométrie de masse éclairée et les chemins de la métallurgie. In *La vie mystérieuse des chefs-d'œuvres. La science au service de l'art*, 85–7. Paris: Editions de la Réunion des musées nationaux.
- Amiran, R., 1960. The pottery of the Middle Bronze I in Palestine. *Israel Exploration Journal* 10: 204–25.
- Arne, T. J., 1945. *Excavations at Shah Tepe, Iran*. Stockholm, The Sino-Swedish Expedition no. 27, VII. Archaeology 5.
- Bader, N. O., 1975. Early agricultural settlement: Tell Sotto (1971, 1973, 1974 seasons). *Soviet Archaeology* 4: 99–111 (in Russian with French summary).
- Bashilov, V. A., Bolshakov, O. G. and Kouza, A. V., 1980. The earliest strata of Yarim Tepe 1. *Sumer* 36 (1–2): 43–64.
- Bazin, D. and Hubner, H., 1969. *Copper deposits in Iran*. Tehran, Geological Survey of Iran, Report 13.
- Beale, T. W., 1973. Early trade in highland Iran: a view from a source area. *World Archaeology* 5: 133–48.
- Berthoud, T., 1979. *Etude par l'analyse de traces et la modélisation de la filiation entre minerai de cuivre et objets archéologiques du moyen orient (IV^{ème} et III^{ème} millénaires avant notre ère)*. Université Pierre et Marie Curie, Paris. Dissertation.

- Berthoud, T., Bensenval, R., Cesbron, F., Cleuziou, S., Pechoux, M., Françaix, J. and Liszak-Hours, J., 1979. The early Iranian metallurgy. Analytical study of copper ores from Iran. In *Proceedings of the 18th international symposium on archaeometry and archaeological prospection*. Köln: Rheinland Verlag.
- Berthoud, T., Bonnefuss, S., de Choux, M. and Françaix, J., 1980. Data analysis: towards a model of chemical modification from ores to metal. In P. T. Craddock (ed.), *Scientific studies in early mining and extractive metallurgy*, London, British Museum Occasional Paper 20.
- Berthoud, T., Cleuziou, S., Hurtel, L. P., Menu, M. and Volfovsky, C., 1982. Cuivres et alliages en Iran, Afghanistan, Oman au cours des IV^e et III^e millénaires. *Paléorient* 8, 2: 39–54.
- Bittel, K., 1959. Beitrag zur Kenntnis anatolischer Metalgefäße der zweiten Hälfte des dritten Jahrtausends v. Chr. *Jahrbuch des deutschen archäologischen Instituts* 74: 1–34.
- Blegen, C. W., Caskey, J. L. and Rawson, M., 1951. *Troy. The third, fourth and fifth settlements*. Princeton University Press.
- Bohne, C., 1965. Zur Präge der Hartung von Kupfer, Waffen und Geräten. *Technische Beiträge zur Archäologie* II, Mainz, Römisch-Germanisches Zentralmuseum: 126–30.
- Bordaz, L. A., 1973. *The metal artifacts from the Bronze Age excavations at Karataş-Semayük, Turkey, and their significance in Anatolia, the Near East and the Aegean*. Bryn Mawr College dissertation, University Microfilms no. 7818512.
- Braidwood, R. J. et al. 1951. Ancient Syrian coppers and bronzes. *Journal of Chemical Education* 28: 87–96.
- Brandt, R. W., 1978. The other Chalcolithic finds. In M. N. van Loon (ed.), *Korucutepe* 2: 61–3. North-Holland Publishing Co., Amsterdam.
- Branigan, K., 1974. *Aegean metalwork of the Early and Middle Bronze Age*. Oxford, Clarendon Press.
- Bulgarelli, G., 1979. The lithic industry of Tepe Hissar at the light of recent excavation. In M. Taddei (ed.), *South Asian Archaeology 1977, Naples*: 39–54. Istituto Universitario Orientale. Seminario di Studi Asiatici Series Minor VI.
- Caldwell, J. (ed.), 1967. *Investigations at Tal-i-Iblis*. Springfield, Illinois, Illinois State Museum Preliminary Reports No. 9.
- Canby, J. V., 1965. Early Bronze Age “trinket” moulds. *Iraq* 27: 42–61.
- Chakrabarti, D. K., 1979. The problem of tin in early India—a preliminary survey. *Man and Environment* 3: 61–74.
- Charles, J. A., 1967. Early arsenical bronzes—a metallurgical view. *American Journal of Archaeology* 71: 21–6.
- Charvát, P., 1982. Early Ur – war chiefs and kings of Early Dynastic III. *Altorientalische Forschungen* 9: 43–59.
- Chmyriov, V. M., et al., 1973. Mineral resources of Afghanistan. In *Geology and Mines and Industries of the Republic of Afghanistan*, I. Kabul.
- Clarke, D. L., 1978. *Analytical archaeology*. 2nd edition, New York, Columbia University Press.
- Cleuziou, S. and Berthoud, T., 1982. Early tin in the Near East: a reassessment in the light of new evidence from Afghanistan. *Expedition* 24 (3): 14–1.
- Contenau, G., and Ghirshman, R., 1935. *Fouilles du Tepe Giyan près de Néhavend, 1931 et 1932*. Paris, Paul Geuthner.
- Crawford, H. E. W., 1974. The problem of tin in Mesopotamian bronzes. *World Archeology* 6: 242–47.
- Crowfoot Payne, J., 1968. Lapis lazuli in early Egypt. *Iraq* 30: 58–61.
- de Jesus, P. S., 1980. *The development of prehistoric mining and metallurgy in Anatolia*. BAR International Series 74, Oxford 1980.
- Delougaz, P. and Lloyd, S., 1942. *Pre-Sargonic temples in the Diyala region*. OIP 58, University of Chicago Press.
- Dörpfeld, W., 1902. *Troja und Ilion*. Athens.
- Dunand, M., 1973. *Fouilles de Byblos* V. Paris, Lebanese Department of Antiquities, Etudes et Documents d'Archéologie VI.
- Dyson, R. H. and Howard, S. M. (eds.) In press. *Preliminary reports of the Tappeh Hesar resurvey project. Mesopotamia*, Naples.
- Easton, D. F., 1976. Towards a chronology for the Anatolian Early Bronze Age. *Anatolian Studies* 26: 145–73.

- Eaton, E. R. and H. McKerrell, 1976. Near Eastern alloying and some textual evidence for the early use of arsenical copper. *World Archaeology* 8: 169–91.
- El-Wailly, F., 1964. Foreword. *Sumer* 20: 1–7.
- Esin, U., 1969. *Kuantitatif Spektrel Analiz Yardımıyla Anadolu' da Başlangıcından Aşur Kolonileri Çağına Kadar Bakır ve Tunç Madenciligi*. Istanbul Üniversitesi Edebiyat Fakültesi Yayınları 1427.
- Falkenstein, A., 1954. La cité-temple sumérienne. *Cahiers d'histoire mondiale* 1: 784–814.
- Foster, B. R., 1977. Commercial activity in Sargonic Mesopotamia. *Iraq* 39: 31–43.
- Foster, B. R., 1980. A new look at the Sumerian temple state. *Journal of the Economic and social History of the Orient* 24: 225–41.
- Francfort, H.-P. and Pottier, M.-H., 1978. Sondage préliminaire sur l'établissement protohistorique harappéen et post-harappéen de Shortugai (Afghanistan du N.-E.). *Arts Asiatiques* 34: 29–64.
- Gale, N. H. and Stos-Gale, Z. A., 1981. Ancient Egyptian silver. *Journal of Egyptian Archaeology* 67: 103–15.
- Gelb, I., 1976. Quantitative evaluation from freedom to slavery. In B. Eichler (ed.), *S. N. Kramer Anniversary Volume, Alter Orient und altes Testament* 25: 195–207.
- Gerstenblith, P., 1980. A reassessment of the beginning of the Middle Bronze Age in Syria. *Bulletin of the American Schools of Oriental Research* 237: 65–84.
- Ghirshman, R., 1938. *Fouilles de Sialk* Vol. I. Paris, Paul Geuthner.
- Goldman, H., 1956. *Excavations at Gözlü Küle, Tarsus* Vol. II. Princeton University Press.
- Güterbock, H. G., 1969. Ein neues Bruchstück der Sargon-Erzählung "König der Schlacht." *Mitteilungen der deutschen Orient-Gesellschaft* 101: 14–26.
- Hakemi, A., 1970. Shahdad. *Iran* 8: 187–8.
- Hakemi, A., 1972. *Catalogue de l'Exposition: Lut. Shadad (Xabis)*. Tehran, Premier symposium Annuel de la Recherche Archéologique en Iran.
- Harrison, J. V., 1968. Minerals. In W. B. Fisher (ed.), *The Cambridge History of Iran. The Land of Iran* Vol. 1. Cambridge University Press.
- Hartmann, A. and Sangmeister, E., 1972. The study of prehistoric metallurgy. *Angewandte Chemie* 11 (7): 620–9.
- Hauptmann, A., 1980. Zur frühbronzezeitlichen Metallurgie von Shahr-i Sokhta (Iran). *Der Anschnitt* 32. 2–3: 55–61.
- Hedges, R. E. M., 1976. Analyses of bronze and other metals from Tell es-Sweyhat. *Iran* 8: 66–7.
- Heinrich, E., 1936. *Kleinfunde aus den archaischen Tempelschichten in Uruk*. Deutsche Forschungsgemeinschaft, Berlin.
- Herrmann, G., 1968. Lapis lazuli: the early phases of its trade. *Iraq* 30: 21–57.
- Herzfeld, E., 1930. *Die Ausgrabungen von Samarra* Vol. 5. Berlin.
- Herzfeld, E., 1932. *Iranische Denkmäler*. Berlin.
- Heskel, D. and Lamberg-Karlovsky, C. C., 1980. An alternative sequence for the development of metallurgy: Tepe Yahya, Iran. In T. A. Wertime and J. D. Muhly (eds.), *The coming of the age of Iron*: 229–65. Yale, University Press, New Haven.
- Hirsch, H., 1963. Die Inschriften der Könige von Agade. *Archiv für Orientforschung* 20: 1–82.
- Kohl, P. L., 1978. The balance of trade in southwestern Asia in the mid-third millennium B.C. *Current Anthropology* 19. 3: 463–91.
- Kohl, P. L., 1979. The "world economy" of West Asia in the third millennium B.C. In M. Taddei (ed.), *South Asian Archaeology 1977*. Vol. 1: 55–85. Istituto Universitario Orientale, Seminario di Studi Asiatici.
- Kohl, P. L., 1981. *The Bronze Age civilization of Central Asia*. M. E. Sharpe, Armonk, N. Y.
- Kraft, J., Kayan, J. and Erol, O., 1982. Geology and paleographic reconstruction of the vicinity of Troy. In G. Rapp and J. A. Gifford (eds.), *Troy. The archaeological geology*: 11–41. Princeton University Press, Troy supplementary monograph 4.
- Kuzmina, E. E., 1966. *Metallicheskie izdelia eneolit i bronzogo veka v srednei Asii*, Moscow.
- Le Breton, L., 1957. The early periods at Susa, Mesopotamian relations. *Iraq* 19: 79–124.
- Lechtman, H., 1980. The Central Andes: metallurgy without iron. In T. A. Wertime and J. D. Muhly (eds.), *The Coming of the Age of Iron*: 267–334. New Haven, Yale University Press.
- Lloyd, S. and Safar, F., 1945. Tell Hassuna: Excavations by the Iraq Government Directorate General of Antiquities in 1943 and 1944. *Journal of Near Eastern Studies* 4: 255–89.

- Lloyd, S. and Mellaart, J., 1962. *Beycesultan I*. British Institute of Archaeology in Ankara, London.
- Lucas, A. and Harris, J. R., 1962. *Ancient Egyptian materials and industries*. London, Edward Arnold, Ltd.
- Maddin, R., Muhly, J. D. and Stech, T. In press. Metal artifacts from the Enan tomb. *Atiqot*, English edition.
- Madjidzadeh, Y., 1979. An early prehistoric coppersmith workshop at Tepe Ghabristan. In *Akten des VII Internationalen Kongresses für iranische Kunst und Archäologie*, Munich 7–10 September 1976.
- Mallowan, M. E. L. and Rose, J. C., 1935. Excavations at Tall Arpahiyah, 1933. *Iraq* 2: 1–178.
- Masson, V. M. and Sarianidi, V. I., 1972. *Central Asia*, London.
- Maxwell-Hyslop, K. R., 1971. *Western Asiatic jewellery, c. 3000–612 B.C.* London, Methuen and Co., Ltd.
- Maxwell-Hyslop, K. R., 1977. Sources of Sumerian gold. *Iraq* 39: 83–6.
- Maxwell-Hyslop, K. R., 1982. The Khosh Tapa-Fullol hoard. *Afghan Studies* 3–4: 25–37.
- McKerrell, H. and Tylecote, R. F., 1974. The working of copper-arsenic alloys in the Early Bronze Age and the effect on the determination of provenance. *PPS*: 267–2.
- Meeks, N. D. and Tite, M. S., 1980. The analysis of platinum group element inclusions in gold antiquities. *Journal of Archaeological Science* 7 (3): 267–76.
- Mellaart, J., 1959. The royal tombs of Dorak. *Illustrated London News* 28 November: 754, colour insert 1–111.
- Mellink, M. J., 1956. The royal tombs at Alaca Hüyük and the Aegean world. In *The Aegean and the Near East. Studies Presented to Hetty Goldman*, J. J. Augustin, Locust Valley, N.Y.: 39–58.
- Mellink, M. J., 1962. The prehistory of Syro-Cilicia. *Bibliotheca Orientalis* 19: 219–26.
- Mellink, M. J., 1965. Anatolian chronology. In R. W. Ehrich (ed.), *Chronologies in Old World Archaeology*: 101–31. University of Chicago Press.
- Mellink, M. J., 1981. Archaeology in Asia Minor. *American Journal of Archaeology* 85: 463–79.
- Mellink, M. J., 1984. Archaeology in Asia Minor. *American Journal of Archaeology* 88: 441–59.
- Merpert, N. I., Munchaev, R. M. and Bader, N. O., 1977. The investigations of the Soviet Expedition in Iraq 1974. *Sumer* 33 (1): 65–104.
- Mitten, D. G. and Yügrüm, G., 1971. The Gygean Lake, 1969: Eski Balıkhane preliminary report. *Harvard Studies in Classical Philology* 75: 191–5.
- Mitten, D. G. and Yügrüm, G., 1974. Ahlatlı Tepecik beside the Gygean Lake. *Archaeology* 27: 22–9.
- Moorey, P. R. S., 1982a. The archaeological evidence for metallurgy and related technologies in Mesopotamia, c. 5500–2100 B.C. *Iraq* 44: 13–38.
- Moorey, P. R. S., 1982b. Archaeology and Pre-achaeonid metalworking in Iran: A fifteen year retrospective. *Iran* 20: 81–101.
- Moorey, P. R. S. and Schweizer, F., 1972. Copper and copper alloys in ancient Iraq, Syria and Palestine: some new analyses. *Archaeometry* 14: 177–98.
- Muhly, J. D., 1973. Copper and tin. *Transactions, The Connecticut Academy of Arts and Sciences* 43: 155–535.
- Muhly, J. D., 1977. The copper ox-hide ingots and the Bronze Age metals trade. *Iraq* 39: 73–82.
- Muhly, J. D., 1978. New evidence for sources of and trade in Bronze Age tin. In A. D. Franklin, J. S. Olin and T. A. Wertime (eds.), *The search for ancient tin*: 43–8. Washington, D.C., Smithsonian Institution.
- Muhly, J. D., 1980. Bronze figurines and Near Eastern metalwork. *Israel Exploration Journal* 30: 148–61.
- Muhly, J. D., 1985. Sources of tin and the beginnings of bronze metallurgy. *American Journal of Archaeology* 89: 275–91.
- Nicholas, I. M., 1980. *A Spatial/Functional Analysis of Late Fourth Millennium Occupation at the TUV Mount, Tal-e Malyan, Iran*. Dissertation, University of Pennsylvania.
- Ogden, J. M., 1976. The so-called “platinum” inclusions in Egyptian goldwork. *Journal of Egyptian Archaeology* 62: 138–44.
- Oren, E. D., 1973. The Early Bronze IV period in northern Palestine and its cultural and chronological setting. *Bulletin of the American Schools of Oriental Research* 210: 20–37.
- Von der Osten, H. H., 1937. *The Alishar Hüyük, Seasons of 1930–32*. OIP 27, University of Chicago Press.
- Özgüç, T., 1958. *Horoztepe. An Early Bronze Age settlement and cemetery*. Ankara, Türk Tarih Kurumu Yayınlarından V, no. 18.
- Özgüç, T., 1964. The art and architecture of ancient Kanish. *Anadolu* 8: 27–48.
- Özbal, H., 1981. İkiztepe kazıları metal bulgu analizleri. In *Tübitak Arkeometri Ünitesi Bilimsel Toplantı Bildirileri* 2: 101–12. Istanbul, Boğaziçi Üniversitesi Publications.

- Pernicka, E., Seeliger, T. C., Wagner, G. A., Begemann, F., Schmitt-Strecker, S., Eibner, C., Oztunali, O. and Baranyi, I., 1984. Archäometallurgische Untersuchungen in Nordwestanatolien. *Jahrbuch des römisch-germanischen Zentralmuseums Mainz* 31: 533–99.
- Pettinato, G., 1981. *The archives of Ebla*. New York.
- Pigott, V. C., Howard, S. M. and Epstein, S. M., 1982. Pyrotechnology and culture change at Bronze Age Tepe Hissar (Iran). In *Early pyrotechnology*: 215–36. Washington, D.C. Smithsonian Institution.
- Piperno, M., n.d. La necropoli—the graveyard. In G. Tucci (ed.), *La città bruciata del deserto salato*: 115–48. Venice, Erizzo Editrice.
- Pottier, M.-H., 1980. Un cachet en argent de Bactriane. *Iranica Antiqua* 15: 167–74.
- Potts, D., 1982. The Zagros frontier and the problem of relations between the Iranian plateau and southern Mesopotamia in the third millennium B.C. In H. J. Nissen and J. Renger (eds.), *Mesopotamien und seine Nachbarn*: 33–55. Berlin, Riemer Verlag, Berliner Beiträge zum Vorderen Orient 1.1.
- Prag, K., 1978. Silver in the Levant in the fourth millennium B.C. In P. R. S. Moorey and P. J. Parr (eds.), *Archaeology in the Levant*, Aris and Phillips Ltd., Warminster: 36–45.
- Pritchard, J. B. (ed.), 1955. *Ancient Near Eastern texts*. Princeton University Press.
- Przeworski, S., 1939. *Die Metallindustrie Anatoliens in der Zeit von 1500–700 vor Chr.* Internationales Archiv für Ethnographie, 36, Supp., Leiden, E. J. Brill.
- Ratnagar, S., 1981. *Encounters. The westerly trade of the Harappan civilization*. Delhi, Oxford University Press.
- Richard, S., 1980. Toward a consensus of opinion on the end of the Early Bronze Age in Palestine-Transjordan. *Bulletin of the American Schools Oriental Studies* 237: 4–34.
- Ryzanov, V., 1979. On general ancient tin ore sources on the territory of Uzbekistan. *Material for the History of Uzbekistan* 15: 98–104.
- Schliemann, H., 1890. *Ilios*. New York, Harper and Bros.
- Schmidt, E., 1937. *Excavations at Tepe Hissar, Iran 1931–33*. Philadelphia University Museum.
- Schmidt, H., 1902. *Heinrich Schliemanns Sammlung trojanischer Altertümer*. Berlin, Georg Reimer.
- Seeden, H., 1980. *The standing armed figurines in the Levant*. Munich, Beck.
- Schaffer, J. G., 1982. Harappan commerce: an alternative perspective. In S. Pastern and L. Flam (eds.), *Anthropology in Pakistan*: 166–210.
- Shareq, A., Chmyriov, V. M., Stazhilo-Alexseev, K. F., Dronov, V. I., Gannon, D. J., Lubemov, G. K., Kafarshiy, A. Kh. and Malyarov, E. P., 1977. *Mineral resources of Afghanistan*, Edition 2 Kabul: Ministry of Mines and Industries. Afghan Geological and Mines Survey, United Nations Development Support Project, AFG/74/012.
- Speiser, E. A., 1935. *Excavations at Tepe Gawra* Vol. 1: Levels I–VIII. Philadelphia, University of Pennsylvania.
- Stech Wheeler, T., 1974. Early Bronze Age burial customs in western Anatolia. *American Journal of Archaeology* 78: 415–25.
- Stech, T., Forthcoming. *The Early Bronze Age Cemetery of Karataş-Semayük*.
- Stos-Gale, Z. A. and Gale, N. H., 1984. Early Bronze Age Trojan metal sources and Anatolians in the Cyclades. *Oxford Journal of Archaeology* 3. 3: 23–41.
- Stronach, D., 1957. The development and diffusion of metal types in Early Bronze Age Anatolia. *Anatolian Studies* 7: 89–126.
- Swiny, S., 1982. Correlations between the composition and function of Bronze Age metal types in Cyprus. In J. D. Muhly, R. Maddin and V. Karageorghis (eds.), *Early Metallurgy in Cyprus*: 69–79. Nicosia, Department of Antiquities.
- Taghizadeh, N. and Mallakpour, M. A., 1976. *Mineral distribution map of Iran*. Tehran, Geological Survey of Iran.
- Taylor, J. W., 1983. Erzgebirge tin: a closer look. *Oxford Journal of Archaeology* 2: 295–98.
- Terekhova, N. N., 1981. The history of metalworking production among the ancient agriculturalists of Southern Turkmenia. In Kohl 1981: 313–32.
- Tobler, A. J., 1950. *Excavations at Tepe Gawra* Vol. II. Museum Monograph, University of Pennsylvania Press, Philadelphia.
- Tosi, M. and Bulgarelli, G. In Press. The Stratigraphic Sequence of Sqs. DR 88/89 on South Hill. In

- R. H. Dyson and S. M. Howard (eds.), *Preliminary Reports of the Tappeh Hesar Restudy Project, 1976. Mesopotamia*.
- Tosi, M. and Wardak, R., 1972. The Fullol hoard: a new find from Bronze-Age Afghanistan. *East and West* n.s. 22: 9–17.
- Tylecote, R. F. and E., 1966. Analyses of Trojan bronze. *Bulletin of the Historical Metallurgy Group* 7: 20–9.
- Vanden Berghe, L., 1968. La nécropole de Bani Surmah. *Archéologia* 24: 53–63.
- Wertime, T. A., 1973. The beginnings of metallurgy: a new look. *Science* 182: 875–87.
- Wertime, T. A., 1978. The search for ancient tin: the geographic and historic boundaries. In A. D. Franklin, J. S. Olin, T. A. Wertime (eds.), *The Search for Ancient Tin*, 1–6. Washington, D.C., U. Government Printing House.
- Whitmore, F. E. and Young, W. J., 1973. Application of Laser Microprobe and Electron Microprobe in the Analysis of Platinum Inclusions in Gold. In W. J. Young *Application of Science in Examination of Works of Art*, 88–95. Boston, Museum of Fine Arts.
- Woolley, C. L., 1955. *Ur Excavations* Vol. IV. Philadelphia, University Museum.
- Wright, G. A., 1974. Archaeology and trade. *Addison-Wesley Module in Anthropology* no. 49.
- Wright, H. T., 1981. *An early town on the Deh Luran plain. Excavations at Tepe Farukhabad*. Ann Arbor Memoirs of the Museum of Anthropology University of Michigan, No. 13.
- Yakar, J., 1979. Troy and Anatolian Early Bronze age chronology. *Anatolian Studies* 29: 51–67.
- Yener, K. A., 1982. A review of interregional exchange in Southwest Asia. *Anatolica* 9: 33–75.
- Yener, K. A., 1983. The production, exchange and utilization of silver and lead metals in ancient Anatolia. *Anatolica* 10: 1–15.
- Young, W. J., 1972. The fabulous gold of the Pactolus Valley. *Bulletin of the Boston Museum of Fine Arts* 70: 5–13.
- Zwicker, U., 1982. Bronze Age metallurgy at Ambelikou-Aletri and arsenical copper in a crucible from Episkopi-Phaneromeni. In J. D. Muhly, R. Maddin and V. Karageorghis (eds.), *Early Metallurgy in Cyprus*: 63–8. Nicosia, Department of Antiquities.